The Pakistan Development Review
43 : 3 (Autumn 2004) pp. 253–266

Estimating Shadow Wage Rates for Economic Project Appraisal

IRAJ SALEH

One of the central concerns in cost benefit analysis is the adjustment of distortions in markets to provide a better guide to a more effective allocation of scarce resources. The objectives of this paper are to develop a model for the estimation of the shadow wage rate (SWR) for groups of occupations and to estimate the SWRs for the major groups of occupations in Australia. The main findings of the analysis indicate that estimated SWRs for major groups of occupations are different from the corresponding market wage rates, and that estimated SWRs of the groups are different. The results of the study demonstrate the importance of estimation of the SWR as a part of the appraisal process of investment projects. The ratio analysis indicates the significance of the difference between SWR and market wage rate, which is recommended to be adjusted is economic analysis of projects.

1. INTRODUCTION

Cost benefit analysis (CBA) has an important role in economic appraisal of projects. The underlying theory of cost benefit analysis is sourced from welfare economics. The main objective of cost benefit analysis is to choose the best alternative option in a consistent manner to maximise the net benefit to the economy. There are some major issues involved in cost benefit analysis, of which the most important are valuation of costs and benefits, shadow pricing, discounting, income distribution, the treatment of uncertainty and the measurement of externalities (e.g., environmental impact study).

One of the central concerns is the analysis of shadow pricing where economic values of costs and benefits are important issues that need to be specifically measured. This method is required to adjust the distortions in markets created by the divergence of the market prices from their economic values. In a competitive economy, economic decision-making should reflect the underlying scarcities to obtain the optimal allocation of resources. In reality, however, there is no such equilibrium, and various factors intervene in pricing mechanism and underlying scarcities. The modification of prices is done through the estimation of "shadow prices". Shadow prices as the true prices, provide a better guide to a more effective allocation of scarce resources.

Iraj Saleh is based at the Department of Agricultural Economics, Tehran University, Karaj, Iran.

This paper considers the estimation of the shadow price of labour as an essential part of project appraisal. The paper is organised as follows. The study initially deals with the principles of the estimation of the SWR in cost benefit analysis and then it draws attention to the role of shadow pricing of labour in Australian Government Agencies and Business Enterprises (GBEs). The focus is then turned to the measurement of the SWRs for the Australian project appraisal. For this purpose, the paper initially proposes a model for the estimation of the SWR for major groups of occupations. The study provides a framework which can be useful to other researchers and analysts who want to examine the pricing of labour in project appraisal. The essential novelty of the analysis is its proposal for a technique to measure the accounting price of labour without having to use data which is obtained from non-publicly available databases.

The model proposes an approach for the estimation of the marginal product of labour through the calculation of the probabilities of job change among the major groups of occupations and the unemployment pool. The proposed model is subsequently used in the estimation of the SWR for the major groups of occupations in Australia. The last section draws attention to conclusions and policy implications.

2. THE SHADOW WAGE RATE IN COST BENEFIT ANALYSIS

In an appropriate appraisal of public investment projects, the economic value of costs and benefits should be determined. In past decades, the methods of project evaluation were developed to suggest ways in which costs and benefits can be adjusted to reflect positive or negative externalities, and to eliminate the effects of distortions caused by market imperfections resulting from various kinds of government policies such as taxes and subsidies. In other words, the need to use shadow pricing in CBA is attributed to distortions in the markets. In different countries, economic values diverge to varying degrees from market prices and values depending on the level of distortions. The issue of market inefficiency has been discussed as a separate field in economics. Market signal, as an inadequate guide for investment planning and project appraisal, does not reflect the economic cost of resources. The market prices should therefore be adjusted in order to provide a more efficient allocation of scarce resources.

There have been attempts to find adequate modifications of values in the appraisal of projects. These modifications are obtained through the calculation of the “border prices”, “accounting prices”, or the “shadow prices” to remove the divergence made by distortions in markets. For the valuation of inputs involved in production, an assumption is required indicating that the price of any input should represent the opportunity cost of that input. This opportunity cost reflects the value of output forgone when used in some other area of production.

Labour, as an important input of production in investment projects, should be valued at its economic cost in order to obtain a more efficient allocation of labour in projects. This section deals with the principles of the estimation of the SWR in the World Bank approach as one of the main approaches involved in CBA. The approach proposed by Squire and Van Der Tak (1975) is the main approach used by the World Bank for project appraisal. Their model constitutes a synthesis of the Little and Mirrlees (1969) and the Dasgupta, Sen, and Marglin (1972) approaches.

In the estimation of the SWR in the World Bank approach, foregone output is considered as the first and most important component of the measurement. Assuming that labour is in fixed supply, a project has to take it away from other employment somewhere else in the economy. Therefore the use of labour in a project prevents its use elsewhere. The foregone output of labour in its best alternative use enters in the analysis as a major component of the economic cost of using the labour. This is the economic value of the marginal product which is added by a single labourer to the public payroll. The opportunity cost of employing labour in a project can be related to the marginal productivity of the labour in its previous job. Obtaining information of the source from which labour is drawn is important. Forgone output denoted by "*m*" is considered as the direct opportunity cost, and is equal to the marginal product of labour. The term "α" is introduced in the estimation as the output conversion factor for estimation of forgone output. It is used to convert the value of forgone output in domestic price to its border price or world price equivalent. Therefore labour's forgone product (at accounting prices) is equal to "$m.\alpha$".

The increase in labour incomes may give rise to higher consumption and possibly some savings. If, at the margin, consumption is less valuable than savings to society, this should be reflected in the SWR and be included as a cost to society. The labour employed in a project is actually paid the amount of the market wage (w), not its social value. If the wage paid to labour in the new job (w), is more than the value of forgone output elsewhere (m), (due to the labour's movement to the new job), and if she/he consumes all of this wage, then the additional cost of hiring labour to the society is equal to "$w–m$". This is the extra consumption generated by the extra income which is earned by the difference between previous wage and project wage.

In the World Bank methodology, the distribution issue is also introduced into project appraisal. The social term of the cost of the extra consumption is obtained through $(w–m)(\beta - \frac{d}{v})$, where "$\frac{d}{v}$" is the value of private consumption at the income level of employed labour relative to the value of income held by the government and available for investment. The term "$w–m$" which is the increase in consumption (measured at marginal prices) is multiplied by an accounting

ratio (β) to obtain the cost to government in terms of forgone foreign exchange and by weight "$\frac{d}{v}$" which reflects the social value of increased consumption.

A consistent disutility of effort can be considered as a sufficient condition in the SWR estimation. This term implies a constant marginal rate of substitution between income and leisure over the range of hours worked per person in the previous (alternative) sector. The labour employed in the project may have to work harder than in his/her previous job. The social valuation of having to work harder is expressed as follows:

$$\textit{Social cost of reduced leisure} = (w-m)F.e.\ \frac{d}{v}$$

where "*F*" can be defined as the proportion of an individual's evaluation that will be valid from the social point of view, "*v*" is the value of uncommitted government income relative to additional private consumption at the average level of consumption. The term "*e*", as the proportion of the wage rate differential, reflects the worker's evaluation of the extra effort in the new job, and "$F.e.\frac{d}{v}$" reflects the social cost of reduced leisure. Therefore the World Bank shadow wage formula with the three components is derived as follows:

$$SWR = m.\alpha + (w-m)(\beta - \frac{d}{v}) + (w-m)\ F.e.\frac{d}{v} \quad \ldots \quad \ldots \quad \ldots \quad (1)$$

where the first component refers to the cost of labour in efficiency price and the second term is the distribution term, and the third component reflects the disutility of effort.

However, in many practical works in the traditional economic analysis, making a number of simplifying assumptions, it is assumed that the forgone output of the labour is the only element of the measurement of the SWR. The assumptions are made regarding government policy, parameters "*d*", "*v*" and the estimated level of the terms "*w–m*", "β", "α", "*F*" and "*e*". It is assumed that the output conversion factor (α) is equal to one which means the domestic value of output is not converted to its world prices equivalent. And also the analysis of distribution of income resulting from undertaking projects, is not applied. While it is acknowledged that the employment of idle labour resources may be at the expense of forgone leisure, however, according to some economists such as Lal (1973), this study uses a zero value for the disutility of effort. In other words it is assumed that there is no disutility involved in reductions in the leisure time of unemployed people.Therefore the SWR is estimated as follows:

$$SWR=m \quad \ldots \quad \ldots \quad \ldots \quad \ldots \quad \ldots \quad \ldots \quad \ldots \quad (2)$$

Considering the approach used by the World Bank for the estimation of the SWR, this paper proposes a model which develops the World Bank approach. The study provides a framework that can be useful to other researchers and analysts who want to examine the pricing of labour in project appraisal.

3. SHADOW PRICING BY AUSTRALIAN GOVERNMENT AGENCIES AND BUSINESS ENTERPRISES

Government agencies and business enterprises (GBEs) play a pivotal role in supplying and managing Australia's economic and social infrastructure. The accountability and performance of these organisations in terms of their investment appraisal criteria is consequently of considerable importance. GBEs in the Australian economy provide a huge number of services to the community with a considerable share in GDP. Project appraisal should therefore be considered as an important element of the economic management of the states and the whole country.

Kearney and Saleh (1998) reported the results of a survey of 30 Government Agencies and GBEs concerning their investment project appraisal processes. One of the most important findings of the study indicates that although many international and Australian studies point to the importance of shadow pricing in public investment project appraisal, many Government Agencies and GBEs in Australia do not include shadow pricing as part of their investment project appraisal processes. This finding is examined in this study which emphasises the necessity of estimation of the SWRs for project appraisal.

4. ESTIMATION OF THE SWRs FOR AUSTRALIAN PROJECT APPRAISAL

This paper proposes a model for the estimation of the SWR for the major groups of occupations. The estimation is done by proposing a novel approach which estimates the SWR entirely from published statistical sources. The approach focuses on the estimation of the marginal product of labour as the main component of the estimation of the SWR. The proposed approach will be subsequently used in the estimation of SWRs in the major groups of occupations in Australia as a case study.

There are some sources of data used in this study which are published by the Australian Bureau of Statistics (ABS). The main source of data in this study is "Labour Mobility". The statistics in this publication were compiled from data collected in the Labour Mobility Survey that was conducted throughout Australia in 2002 as a supplement to the monthly Labour Force Survey (LFS). The publication "*Labour Force*" contains information about survey design, sample redesign, scope, coverage and population benchmarks relevant to the monthly LFS, which also apply to supplementary surveys. It also contains definitions of demographic and labour force characteristics, and information about telephone interviewing which are relevant to both the monthly LFS

and supplementary surveys. The Labour Mobility Survey was conducted in both urban and rural areas in all states and territories. Other ABS publication used in this study is "*Employee Earnings and Hours*". This publication contains estimates of average earnings based on information obtained from a sample survey of employers. The data represent average gross (before tax) earnings of employees.

As mentioned earlier, there are a few main components of the measurement of the SWR in the World Bank approach. The forgone output, "*m*", is the major part of the estimation of the shadow pricing of labour. In the literature on shadow pricing of labour, Little and Mirrlees (1974) and Dasgupta, Sen and Marglin (1972) put forward that in the absence of sufficient information and data on the foregone output of labour, the wage in the previous job is used as the first approximation of the marginal product of labour. In this study, because of the lack of data on income in the previous job in published data sources, this parameter is estimated in an indirect manner. In order to estimate the wage in the previous job, it is possible to use some variables which are related to the situation of labour in the previous job which can be associated with the wage in the current job.

In the data provided on labour mobility, job change is considered on annual basis. In this study, it is assumed that the annual basis of job change is the basis for the measurement of the marginal product of labour or forgone output.

Since published data contains no information on wages in the previous job, the procedure which is used to estimate the wages in the previous job is based on the application of the probabilities of labour mobility among the major groups of occupations and the unemployment pool. According to the data available in the ABS publication on labour mobility, this probability can be calculated for each individual occupation. Based on these probabilities, and the average wages received by employees working in each category, the average wage of each individual group of occupations in the previous job can then be estimated.

In order to obtain the probabilities of job change (P_i) of employees working in any major group of occupations, the number of people who were working in the previous year in other major groups of occupations or who might be unemployed, can be divided by the total number of the people working in the selected group. For example, in order to obtain the probabilities of job change for managers and administrators (P_1) in year 2002, the number of managers and administrators who were working in year 2001 in the other major groups of occupations or might be unemployed, are divided by the total number of managers and administrators working in year 2002. This procedure is also applied to the other occupations to obtain the probabilities of transferring employment from the other major groups of occupations or unemployment pool to be a manager or an administrator. The probabilities of estimated job change between other major groups of occupations or the unemployment pool are denoted by P_{12}, P_{13},....., P_{110} and are shown in Table 1 for the year 2002.

Table 1

The Probabilities of Job Change from the Major Groups, of Occupations, and Unemployment Pool to be a Manager/Administrator (2002)

P_{ij}	Probabilities of Job Change
$P_{11}(P_1)$	0.95
P_{12}	0.01
P_{13}	0.005
P_{14}	0.003
P_{15}	0.001
P_{16}	0.006
P_{17}	0.003
P_{18}	0.001
P_{19}	0.002
P_{110}	0.014
Total	1

Source: The Australian Bureau of Statistics (ABS) (2002) *Labour Mobility*. Australia.

The estimation of the wage in the previous job for a person of an individual household can be obtained using the following formula:

$$m_{hi} = (P_i)(Y_{hi}) + \sum_{\substack{j=1 \\ j \neq i}}^{n+1} (P_{ij})(\overline{Y}_j) \qquad \ldots \quad \ldots \quad \ldots \quad \ldots \qquad (3)$$

where "i" represents the occupational group number, "m_{hi}" is the estimated wage in the previous job of a given reference person of a given household who works in one of the major occupational group denoted by "i". The number of each individual household is denoted by "h". The total number of major groups of occupations is shown by "n", and "$n+1$" indicates the total number of groups of occupations and the group of unemployed people. "P_i" refers to the probability of the reference person in a selected household having the same occupation as in the previous job held. For example, "P_1" represents the probability that a reference person who is a manager/administrator in his/her current job and who was also a manager/administrator in the previous job as well. In the following analysis both "P_1" and "P_{11}" have the same meaning and the corresponding notations are the same for the other major groups of occupations. "P_{ij}" is the probability of being employed in the other major groups of occupations or drawing from the unemployment pool. The average total earnings paid to the employees and the income of unemployed

people of different major groups of occupations is denoted by $\overline{\overline{Y_j}}$. In $\sum_{\substack{j=1 \\ j\neq i}}^{n+1}(P_{ij})(\overline{Y}_j)$, the term "$j \neq i$" indicates that the calculation of $(P_i)(Y_{hi})$ is not repeated for each specific group of occupations whose income has been already estimated by the term $(P_i)(Y_{hi})$.

In order to produce more accurate estimation of the wage in the previous job, the data on labour mobility are collected from the ABS publications of the last three publications (1998, 2000, 2002) in which the ABS has published data on labour mobility. Considering the formula mentioned for the estimation of wage in the previous job of the major groups of occupations for the year 2002 in Equation 3, the following formula is developed by:

$$m_i = (AP_i)(\overline{\overline{Y_i}}) + \sum_{\substack{j=1 \\ j\neq i}}^{n+1}(P_{ij})(\overline{Y}_j) \qquad \ldots \qquad \ldots \qquad \ldots \qquad \ldots \qquad (4)$$

The above formula indicates that for each individual group of occupations the average wages in the previous job can be estimated using the average probabilities of job change among the major groups of occupations and the unemployment pool.

In order to use probabilities in the estimation of the wage in the previous job, the averages of the probabilities are taken over the period. In Table 2, the calculated probabilities of job change are placed in the matrix.

In the table "AP_{ij}" represents the average probability of employees transferring from the other major groups of occupations or from the unemployment pool to their current job. For example, if "AP_{12}" is equal to 0.01, "AP_{12}", indicates the average probability that a manager or an administrator comes from the second major group of occupations. In Equation 4, $\sum_{\substack{j=1 \\ j\neq i}}^{n+1}(P_{ij})(\overline{Y}_j)$ indicates the sum of estimated wages of all other occupations with regard to the probabilities of job change. Using the average probabilities of job change and the average earnings of the major groups of occupations and unemployed people, the wage in the previous job can be estimated.

5. THE MODEL FOR THE ESTIMATION OF THE SWR

In order to estimate the shadow wages based on the approach mentioned in this study, "m" should be estimated as the wage in the previous job. In the previous section the formula used for the estimation of the SWR by the World Bank in most practical works has been shown as follows:

$$SWR = m$$

Table 2

The Probabilities of Job Change for the Major Groups of Occupations in Australia (1998, 2000, 2002)

Major Groups of Occupations	Managers and Adminis-trators	Profes-sionals	Associate Profes-sionals	Trade-persons and Related Workers	Advanced Clerical and Service Workers	Intermediate Clerical, Sales and Service Workers	Intermediate Production and Transport Workers	Elementary Clerical, Sales and Service Workers	Labourer and Related Workers	Not Wo in Pre Ye
1. Managers and Administrators	AP_{11}	AP_{12}	AP_{13}	AP_{14}	AP_{15}	AP_{16}	AP_{17}	AP_{18}	AP_{19}	AP
2. Professionals	AP_{21}	AP_{22}	AP_{23}	AP_{24}	AP_{25}	AP_{26}	AP_{27}	AP_{28}	AP_{29}	AP
3. Associate Professionals	AP_{31}	AP_{32}	AP_{33}	AP_{34}	AP_{35}	AP_{36}	AP_{37}	AP_{38}	AP_{39}	AP
4. Tradepersons and Related Workers	AP_{41}	AP_{42}	AP_{43}	AP_{44}	AP_{45}	AP_{46}	AP_{47}	AP_{48}	AP_{49}	AP
5. Advanced Clerical and Service Workers	AP_{51}	AP_{52}	AP_{53}	AP_{54}	AP_{55}	AP_{56}	AP_{57}	AP_{58}	AP_{59}	AP
6. Intermediate Clerical, Sales and Service Workers	AP_{61}	AP_{62}	AP_{63}	AP_{64}	AP_{65}	AP_{66}	AP_{67}	AP_{68}	AP_{69}	AP
7. Intermediate Production and Transport Workers	AP_{71}	AP_{72}	AP_{73}	AP_{74}	AP_{75}	AP_{76}	AP_{77}	AP_{78}	AP_{79}	AP
8. Elementary Clerical, Sales and Service Workers	AP_{81}	AP_{82}	AP_{83}	AP_{84}	AP_{85}	AP_{86}	AP_{87}	AP_{88}	AP_{89}	AP
9. Labourer and Related Workers	AP_{91}	AP_{92}	AP_{93}	AP_{94}	AP_{95}	AP_{96}	AP_{97}	AP_{98}	AP_{99}	AP
1. Managers and Administrators	0.953	0.010	0.005	0.003	0.001	0.006	0.002	0.001	0.002	0.0
2. Professionals	0.004	0.916	0.006	0.002	0.002	0.009	0.002	0.005	0.001	0.0
3. Associate Professionals	0.005	0.007	0.900	0.005	0.003	0.011	0.004	0.008	0.004	0.0
4. Tradepersons and Related Workers	0.002	0.001	0.003	0.901	0.000	0.004	0.007	0.005	0.010	0.0
5. Advanced Clerical and Service Workers	0.002	0.003	0.006	0.002	0.892	0.026	–0.004	0.010	0.002	0.0
6. Intermediate Clerical, Sales and Service Workers	0.002	0.005	0.008	0.004	0.005	0.825	0.004	0.018	0.006	0.1
7. Intermediate Production and Transport Workers	0.002	0.002	0.004	0.012	0.001	0.005	0.860	0.008	0.017	0.0
8. Elementary Clerical, Sales and Service Workers	0.001	0.0003	0.008	0.004	0.002	0.020	0.005	0.754	0.012	0.1
9. Labourer and Related Workers	0.002	0.003	0.004	0.013	0.000	0.011	0.017	0.013	0.756	0.1

Source: The Australian Bureau of Statistics (ABS) (2002) *Labour Mobility.* Australia, (Catalogue number: 6209.0) and author's calculations.

Taking the approach proposed in this study into account, the model for the measurement of the SWR is proposed as follows:

$$SWR_i = (AP_i)(\overline{Y_i}) + \sum_{\substack{j=1 \\ j \neq i}}^{n+1} (P_{ij})(\overline{Y}_j) \qquad \ldots \qquad \ldots \qquad \ldots \qquad \ldots \qquad (5)$$

Using the data required for the estimation of the SWR, in the following Table 3 SWRs have been estimated for the major groups of occupations in Australia:

Table 3

Estimation of SWRs for the Major Groups of Occupations in Australia

The Major Groups of Occupations	$\overline{Y_i}$ (*AUS$*)	AP_i	$(AP_i)(\overline{Y_i})$	$\sum_{\substack{j=1 \\ j \neq i}}^{n+1} (AP_{ij})(\overline{Y}_j)$	*SWRi* (*AUS$*)
1. Managers and Administrators	1418.5	0.95	1352.29	27.45	1379.7
2. Professionals	880.5	0.92	806.48	39.15	845.6
3. Associate Professionals	854.2	0.90	768.86	49.17	818
4. Tradepersons and Related Workers	722.26	0.90	650.57	41.39	691.9
5. Advanced Clerical and Service Workers	618.3	0.89	551.27	44.47	595.7
6. Intermediate Clerical, Sales and Service Workers	544.7	0.83	449.52	64.19	513.7
7. Intermediate Production and Transport Workers	747.5	0.86	643.02	59.33	702.3
8. Elementary Clerical, Sales and Service Workers	366.2	0.75	276.12	92.43	368.5
9. Labourer and Related Workers	508.9	0.76	384.95	97.73	482.6

Sources: The Australian Bureau of Statistics (ABS) (2002) *Labour Mobility.* Australia (Catalogue number: 6209.0) and The Australian Bureau of Statistics (ABS) (2002) *Employee Earnings and Hours.* Australia (Catalogue number: 6306.0) and author's calculations.

In the above table the main elements of the formula of the SWR, have been presented. Using the market wage rate of the major groups of occupations and the calculated probabilities for job change, the SWRs for the major groups have been estimated.

The main findings of the above estimations are as follows: *first*, the estimated SWRs for all major groups of occupations are different from the corresponding MWRs. This indicates that there are distortions in all groups in the labour market. *Second*, the analysis demonstrates that estimated SWRs of the groups are different. This in turns shows that the degree of distortion in some of the major groups of occupations are different from others. It indicates that the necessity and importance of adjustment in labour markets with higher distortions is more than in markets with lower distortions.

6. THE RELATIONSHIP BETWEEN THE SWR AND THE MWR

In studies on the measurement of the SWR, there is a comparison between the estimated SWR and the market wage rate (MWR). In this study the relationship between the estimated SWRs and the MWRs for the major groups of occupations using ratio analysis are examined.

The ratio of two kinds of wages as conversion factor (CF) or "shadow wage adjustment factor" shows to what extent the SWR is close to the MWR. In order to estimate the CFs, the averages of the SWRs estimated for the major groups of occupations are divided by the corresponding MWRs. In this study average weekly total earnings are used as MWRs for the major groups of occupations in Australia. The estimated CFs are presented in Table 4.

Table 4

Estimation of the CFs for the Major Groups of Occupations

Major Groups of Occupations	The Estimated SWRs	Market Wage Rates (MWRs)	Conversion Factors (CFs)
1. Managers and Administrators	1379.7	1418.5	0.97
2. Professionals	845.6	880.5	0.96
3. Associate Professionals	817.8	854.2	0.96
4. Tradepersons and Related Workers	691.9	722.2	0.96
5. Advanced Clerical and Service Workers	595.7	618.3	0.96
6. Intermediate Clerical, Sales and Service Workers	513.7	544.7	0.94
7. Intermediate Production and Transport Workers	702.3	747.5	0.94
8. Elementary Clerical, Sales and Service Workers	368.5	366.2	1.01
9. Labouresr and Related Workers	482.6	508.9	0.95

Source: The Australian Bureau of Statistics (ABS) (2002) *Employee Earnings and Hours.* Australia (Catalogue number: 6306.0) and author's calculations.

As mentioned above, the CFs are used to show the degree of adjustment required for the wages of the major groups of occupations involved in the labour market. In the results, the values of the estimated CFs for the various major groups of occupations indicate to what extent the cost of the labour employed in these groups of occupations should be adjusted. As expected, in the results the CFs for the major groups of occupations are not equal to one. This is because of the wage fixing system in the labour market in Australia.

7. CONCLUSIONS AND POLICY IMPLICATIONS

Shadow pricing, as one of the central concerns in CBA, is to adjust the distortions in markets. This paper draws attention to the importance of the estimation of the SWR in labour markets with distortions. The study also develops a model for the measurement of the shadow wage rates. The main idea behind this estimation is

that the measurement of the shadow pricing of labour, which is largely ignored in most countries, is recommended as an important part of project appraisal. This study emphasises that ignoring the shadow pricing of labour may lead to sub-optimal investment.

The present study proposes an approach to the treatment of labour costs in project appraisal which can be useful to other researchers and analysts who wish to examine the pricing of labour in project appraisal. The study develops the traditional method proposed by the World Bank, and employs the probabilities of job change as a basis to estimate the wage in the previous job as forgone output. The proposed model has been subsequently used in the estimation of the SWRs in Australia. The essential novelty of the analysis is its proposal for a technique to measure the shadow wages without having to use data which is obtained from non-public databases. In other words, the study proposes a methodology to estimate the SWR entirely from published statistical sources. The approach enables the estimation of the marginal product of labour in circumstances under which the required data on the marginal product of labour is not publicly available. This has the effect of reducing the cost of estimating the SWR from generated data.

In order to estimate the forgone output, the data of labour mobility has been used as the main component for measuring the SWRs. The data provides information about job change on an annual basis. The probabilities of job change in different groups of occupations have been calculated to obtain the probabilities of a person transferring from a specific major group of occupations to another major group or the unemployment pool. Using the approach to measure marginal product of labour, the SWRs have been estimated for the major groups of occupations. Since there is a wage fixing system in the labour market in Australia which leads to labour market distortions, this study examines the estimation of the SWR for the Australian project appraisal as a case study.

The main findings of the analysis indicated that estimated SWRs for all major groups of occupations are different from the corresponding MWRs. This is because of the distortions in the labour market. The analysis also demonstrates that estimated SWRs of the groups are different. This in turns shows that the differences in the degree of distortion in the major groups of occupations are different. The results emphasise the necessity and importance of adjusting the wages for project appraisal.

The study shows the significance of the difference between SWRs and the MWRs which is recommended to be adjusted in economic analysis of projects. These results indicate the degree of distortions involved in the labour market. The adjustment conversion factor as an indicator using the relationship between the SWR and the MWR was examined by ratio analysis to show the degree of distortion involved in the labour market for the major groups of occupations. The differences between the SWRs and the MWRs have impacts on total costs of the projects which

in turn may have significant effects on B/C ratio. The B/C ratio is used to make priority order among competing projects.

In general, studies on the estimation of the total economic labour cost of projects enable the decision-makers of projects to compare the labour cost with the estimated total cost of labour based on market wages. The significance of the estimated SWR is different for different projects. It depends on factors such as the type of labour required for the project in terms of level of skill and type of corresponding labour market and distortions involved; and also the type of projects in terms of the degree of labour intensity. The significance of the estimation of SWRs can be examined by considering the difference between the estimated SWR and the MWR, and the share of the difference in the total labour cost based on the MWR.

Overall, the results are considered to be an important part of the project appraisal in comparison to the estimation of the total cost of projects based on the market wage rate. The results of the study are significant not only in the context of Australian project appraisal but also in general for economic project appraisal in other countries where labour markets involve distortions. Therefore the developed model proposed in this study can also be employed for different types of projects and this approach can be of use in future project appraisal. The results of the study on the total labour cost can be considered as important information for decision-makers. They can use the findings of the study to incorporate a complete economic analysis and make an appropriate economic decision. This information can also be used to predict other relevant factors which are related to the human resource aspects of projects. However, there is of course, the necessity for further study and empirical research to analyse project appraisal in an economy. There is also a need for a comprehensive study of the labour market in order to obtain further information on the sources of distortions which lead to the importance of using shadow pricing in the first place.

REFERENCES

Dasgupta, P., A. Sen, and S. Marglin (1972) *Guidelines for Project Evaluation.* UNIDO.

Kearney, Colm., and Iraj Saleh (1998) Shadow Pricing and Project Evaluation by Australian Government Agencies and Business Enterprises. *Journal of Accountability and Performance* 4:1.

Lal, D. (1973) Disutility of Effort, Migration, and the Shadow Wage Rate. *Oxford Economic Papers* 25:1.

Little, I. M. D., and J. A. Mirrlees (1969) *Manual of Industrial Project Analysis in Developing Countries*. Vol. II, OECD.

Squire, L., and H. G. Van Der Tak (1975) *Economic Analysis of Projects.* John Hopkins.

The Australian Bureau of Statistics (ABS) (2002) *Employee Earnings and Hours*. Australia (Catalogue Number: 6306.0).

The Australian Bureau of Statistics (ABS) (2002) *Labour Mobility*. Australia. (Catalogue Number: 6209.0).

The Australian Bureau of Statistics (ABS) (1998) *Labour Mobility*. Australia. (Catalogue number: 6209.0).